METEOROLOGICAL PROBLEMS OF RIGID AIRSHIPS

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The growth of aeronautics has not only greatly increased interest in and use of meteorological information, but has laid before the meteorologist new problems, some of which he has never before considered of any great practical importance. The operation of rigid airships in particular brings up many conditions about which exact information is required. The following notes, submitted recently outline specifically some of the conditions which are of interest. Obviously, exact and permanent answers to these questions are impossible. Climatological data are never final. Studies are under way, however, with the view to obtaining information of the conditions outlined. General interest among meteorologists will no doubt bring to light much more information which up to the present time has not been published.

The weather conditions which interest the airship designer and the airship navigator most are gale winds, squalls, especially those not accompanied by clouds and precipitation, and sudden gusts. Given definite information of the intensity, extent, etc., of these conditions the designer and navigator can take the steps necessary to surmount their effects. Some of the subjects about which airship interests require more accurate information are:

(*a*) The maximum sudden changes in wind velocity likely to be encountered by airships. This refers to the probable greatest difference between the lull and peak of a wind gust within a few seconds and the frequency of occurrence of these conditions.

(NOTE.—The qualification "probable" or "likely" must be applied to these problems, because there is actually no *practical* limit to the intensity of the weather conditions which may exist. "Likely" and "probable" are taken to include all conditions which airships might be expected to experience at one time or another over a period of 5 or 10 years in regular and frequent operation over the "known" parts of the earth, excepting, of course, the very violent conditions such as tornadoes, thunderstorms, etc., which must be avoided by the usual precautions.)

There is at present considerable information and data available on the above subject and some data on subjects following, but information is not as detailed and accurate as is necessary, especially for design purposes.

(*b*) The maximum acceleration (rate of change) of wind velocity likely to be encountered while the wind direction remains constant. Also the frequency of occurrence of these maximum changes.

(*c*) The maximum change in wind direction likely to be encountered while the velocity remains practically constant. Also the frequency of occurrence.

(*d*) The maximum changes in both the wind direction and the wind velocity which are likely to occur at the same time. Also frequency.

(*e*) The maximum space rate of change in direction and velocity, that is, the maximum change in direction and/or velocity likely to be encountered within a given distance, say, a ship's length of about 800 feet.

(*f*) The minimum distance within which opposing vertical currents of a certain *critical* intensity are likely to be encountered. Also, the frequency. Or, the maximum net difference in velocity which is likely to be encountered within a horizontal distance of, say, 800 feet, of two adjacent, vertical, *sustained* air currents. Especially, in clear air, or in air without the usual towering cumulus clouds which accompany violent convectional currents.

(NOTE.—The intensity of these conditions in well-developed thunderstorms is known to reach values which would be dangerous to the sturdiest aircraft.)

(*g*) The maximum difference in velocity and direction of two horizontal wind currents likely to be encountered within a vertical distance of 100 or 150 feet.

(*h*) The horizontal and vertical extent and the "thickness" in each of the above cases, of wind accelerations exceeding a certain critical value. (These, in order to determine the practicability of circumnavigation.) Also their persistency, in length of time; that is, the total period of their existence.

(*i*) The rapidity with which the foregoing large discontinuities in wind can develop and die out.

In all of the above cases, the conditions needing attention are those which are sustained for an appreciable length of time; that is, for more than a fraction of a second. The conditions should be investigated separately for surface and for upper air. The limits in these different regions will not only be different, but the methods of meeting the conditions on the ground will differ from those in the air. The relative intensity and frequency at various altitudes is important. These conditions need to be studied for different regions, because some regions are more favorable for the formation of violent conditions than are others.

WHENCE COME COLD WAVES?

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The literature on the place of origin of cold waves is rather extensive; nevertheless it must be admitted that beyond a general belief that the polar regions are the ultimate source of supply of cold air, little definitive evidence on the subject is at hand.

The explanation of the occurrence of both cold waves and warm waves is to be found in a better knowledge of the N–S component of motion in the atmosphere. It is a matter of common knowledge that the movement of warm air from low to high latitudes is not continuous in the sense that an uninterrupted flow takes place. Because of the fact that cyclones and anticyclones, the two phenomena most directly concerned in the interzonal circulation, are more or less ephemeral, in the sense that they lack continuity of movement across the earth's surface due to changes in environment or what not, uninterrupted flow is not possible. Warm air is transported poleward through the medium of cyclones. The current of warm air, however, may be cut off from the source of supply and then the cyclone, in the nomenclature of the Norwegian school of meteorologists, is said to be "occluded" and soon disappears; generally, but not always, a fresh cyclone is formed a few degrees eastward and southward, where a new current of warm air takes up its journey poleward. This is the principal reason why an uninterrupted passage is impossible; as a matter of fact, there are so many gradations in the volume and speed of movement in both directions, N–S, and the reverse, that it is quite impossible to treat the subject in a detailed way.

In this paper the chief emphasis will be placed on the large variations of pressure and temperature in an attempt to correlate changes in those elements with subsequent weather in the Temperate Zone of the Northern Hemisphere.